# Simulation of Signal Decomposition and Tracking with the GRETA Prototype Detector

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The ability to determine the positions and energies of individual $\gamma$-ray interactions within a highly-segmented Ge crystal is key in the concept of GRETA. Previous work in this area has shown that the position sensitivity of the GRETA Prototype detector is sufficient to resolve interactions down to the desired position resolution of 2 mm [1]. Using simulated detector signals, we have examined the decomposition and tracking process for a single GRETA detector.

The simulation was performed by modeling interactions from a 662 keV source 12 cm from the detector. Signals were calculated for each of the modeled events and then put through the decomposition process. The decomposition code developed utilizes a sequential quadratic programming (SQP) method to minimize the difference between the input simulated signal and a set of basis signals representing single interactions on a grid throughout the crystal. The code was constructed to allow for up to two interactions per detector segment and returned the position and energy of each interaction determined. The position and energies of the interactions were then put through a tracking algorithm which calculated a figure of merit for each of the events. The figure of merit represents the fit of the tracked interactions to that of the Compton-scattering formula. By placing constraints on the figure of merit values the relative peak-to-total and efficiency values have been examined.

Both the peak-to-total and relative full-energy efficiency, obtained through simulation, for the prototype detector were approximately 36% without performing tracking. Figure 1 shows the tradeoff between relative full-energy efficiency and the peak-to-total ratio after performing tracking by varying the constraint on the figure of merit. Figure 2 shows a comparison of the energy spectrum before and after tracking. The current results show a substantial peak-to-total improvement with a relatively small drop in efficiency. We believe with improvement in the decomposition process further gains will be possible. These results were obtained using the full implementation of all data analysis algorithms and thus represent a major step in GRETA development.

*References*

1. K. Vetter, et al., Nucl. Instr. and Meth. A 452 (2000) 105

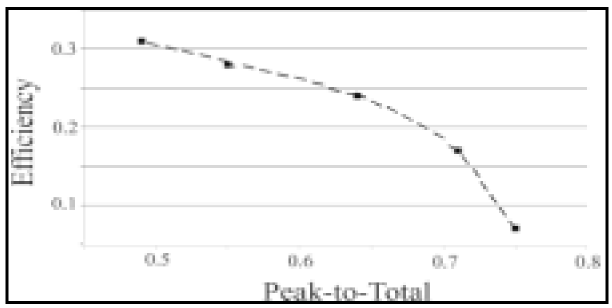


Fig. 1. Tradeoff between peak-to-total ratio and full-energy efficiency for simulated 662 keV events.

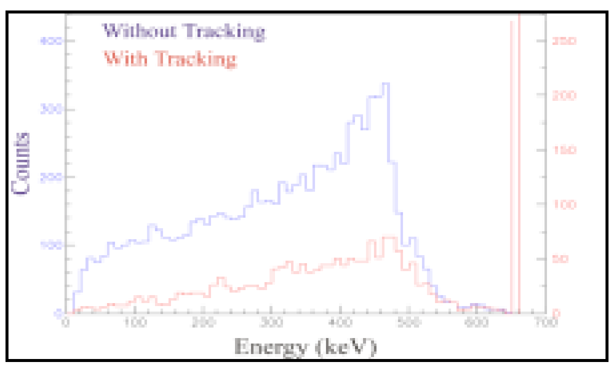


Fig. 2. Simulated energy spectrum for 662 keV events with and without tracking (peak heights normalized).